Pollution Source Survey and Water Quality Assessment of the

Wepawaug River Watershed in Milford and Orange, CT

Conducted by:

The Wepawaug River Watershed Alliance (WRWA)

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Introduction

The City of Milford, CT is a coastal community with over 21 miles of shoreline. Residents enjoy many water-related recreational activities along the shore and in Long Island Sound. There are more than ten (10) commercial shellfish companies operating in Milford's waters growing oyster and clams on more than 120 leased shellfish grounds.[1] Milford also offers recreational shellfishing resources.

The Wepawaug River is the second largest river in Milford encompassing an estimated 23 square miles of watershed running twelve miles northward through Milford, Orange and Woodbridge, CT.[2] Flows from the Wepawaug directly impact Milford Harbor carrying bacteria and chemicals that result in contamination, and sediments that fill the harbor and smother oyster seed growing in the natural shellfish beds of the harbor. In addition to shellfish growing areas, there are two prime recreational bathing beaches located in the Gulf area that are subject to closure during the summer if the if bathing beach samples reveal elevated levels of bacteria.

Bathing beaches and shellfishing areas off Milford are impacted by pollutant loading especially after rainfall events similar to other coastal and inland areas across CT. Inland lakes are also impacted north of Long Island Sound (LIS). Health Departments are forced to close areas to recreational swimming and both recreational and commercial shellfishing due to the potential health concerns from bacterial, viral and contaminant loadings. Areas remain closed until sufficient time has passed and conditions return to "normal" with bacteria levels below the US Environmental Protection Agency (EPA)[3] and US Food and Drug Administration (FDA) limits.[4] The EPA and CT Department of Public Health (DPH) *Escherichia coli* (*E. coli*) bacteria limits for freshwater bathing areas is a single sample level of 235 CFUs (colony forming units)/100 ml with a geometric mean of not greater than 125 CFUs/100ml. The criteria for recreational non-swimming is a single *E. coli* sample of 410 CFUs/100 ml and geometric mean of <126 CFUs/100 ml.[3] Shellfishing areas are closed with water sample fecal coliform results of >14 CFUs/100 ml and geometric means of >31 CFUs/100ml.[4]

The CT Department of Energy and Environmental Protection (DEEP) has listed this tributary as "impaired" in accordance with criteria of the EPA.[3,5] This was assessed and included in the CT 2010 303(D) lists of impaired waterbodies. The CT DEEP has classified the lower portion of the Wepawaug River as a Class AA and impaired due to bacterial elevations. There are only four sampling locations along the Wepawaug in Milford that have been sampled sporadically over the past several years by the CT DEEP in the development of an EPA required Total Daily Maximum Load (TMDL) plan. (CT DEEP 2012 Wepawaug River Watershed Summary[5])

This area is further described by the DEEP as the following:
The Wepawaug River watershed covers an area of approximately 12,743 acres in the southern coastal area of Connecticut (Figure 1). There are several municipalities located at least partially in the watershed, including the City of Milford and the Towns of Orange and Woodbridge, CT. The Wepawaug River watershed includes five segments impaired for recreation due to elevated bacteria levels. These segments were assessed by Connecticut Department of Energy and Environmental Protection (CT DEEP) and included in the CT 2010 303(d) list of

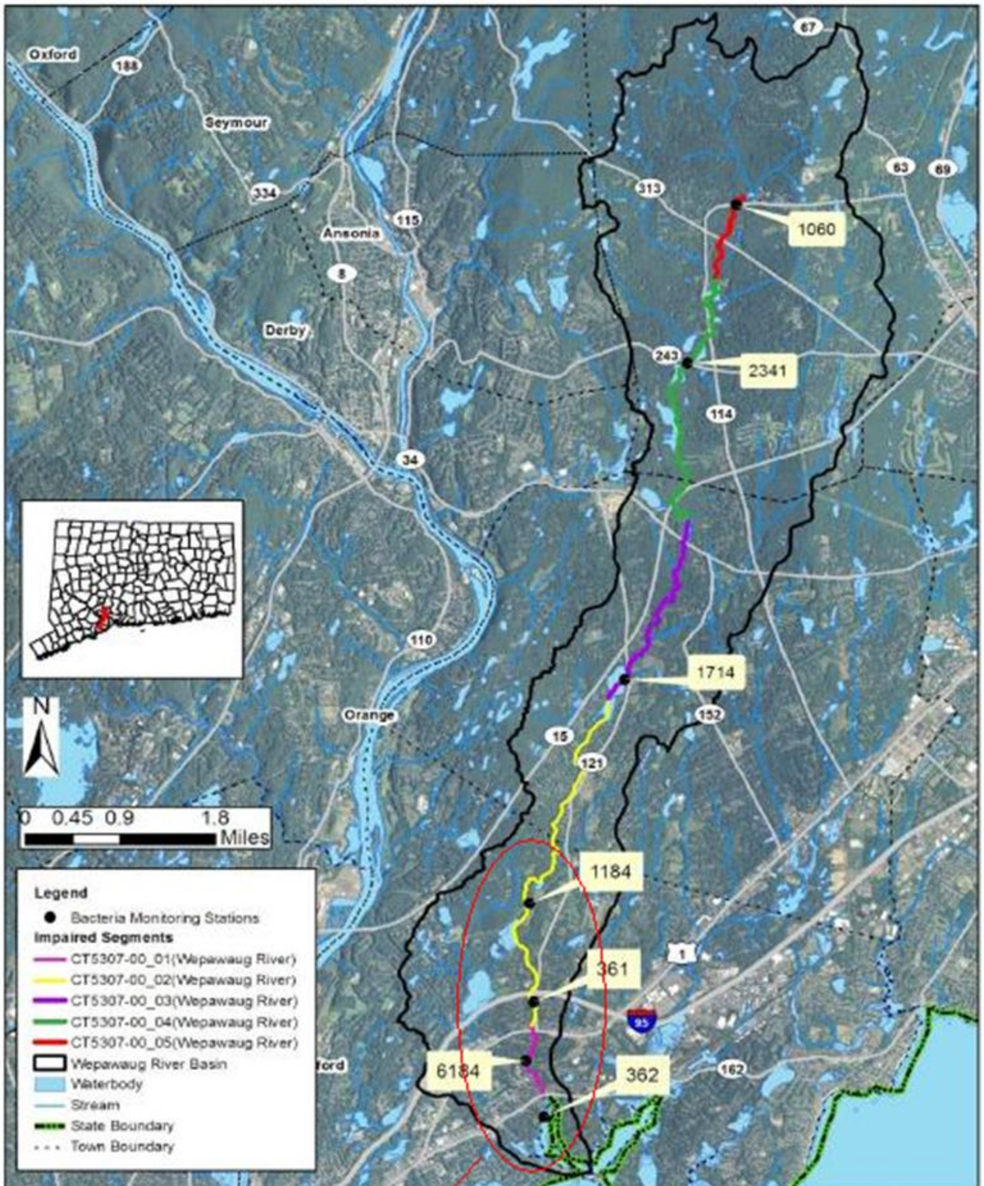
impaired waterbodies. Wepawaug River (Segment 4) (CT5307-00-04) begins at the downstream terminus of Wepawaug River (Segment 5), continues south into Orange, and ends at the inlet to the Wepawaug Reservoir. Wepawaug River (Segment 4) is 3.05 miles long and is located within Towns of Woodbridge and Orange (Figure 2). Wepawaug River (Segment 3) (CT5307-00_03) begins at the downstream terminus of Wepawaug River (Segment 4) at the inlet to the Wepawaug Reservoir, flows south, and ends at the inlet to Lake Wepawaug east of Arrowhead Drive and west of Grassy Hill Road (Route 121) in Orange. Wepawaug River (Segment 3) is 2.33 miles long and is located entirely within the Town of Orange. Wepawaug River (Segment 2) (CT5307-00_02) begins at the inlet to Lake Wepawaug between Route 121 and Route 15 in Orange, flows south into Milford, and ends at the US Route 1 crossing in Milford. This segment is 4.2 miles long and is located in the Town of Orange and the City of Milford. Wepawaug River (Segment 1) Wepawaug River Watershed Summary FINAL Wepawaug River Watershed Summary September 2012 Wepawaug River Watershed TMDL Page 2 of 39 (CT5307-00_01) begins at the US Route 1 crossing in Milford, flows south through dense residential development, and ends at the Route 162 crossing just above the tidal influence of Milford Harbor. This segment is 0.77 miles long and is entirely within the City of Milford. Segments 1, 2, and 3 of the Wepawaug River have a water quality classification of A. Designated uses include potential drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. Segments 4 and 5 of the Wepawaug River have a water quality classification of AA. Designated uses include existing or proposed drinking water supplies, habitat for fish and other aquatic life and wildlife, recreation, navigation, and industrial and agricultural water supply. These segments are impaired due to elevated bacteria concentrations, affecting the designated use of recreation. As there are no designated beaches on Segments 1, 2, and 3, the specific recreation impairment is for non-designated swimming and other water contact related activities. There are designated beaches on Segments 4 and 5, and the specific recreation impairment is for designated swimming. (See page 4.)

To date, no long-term studies or sampling have been conducted in any of the watersheds in Milford that adequately assess the sources of bacteria, chemical, and sediment contamination. The Wepawaug River was chosen as the first tributary to begin studying because it flows directly into Milford Harbor and extends up a total of over twelve (12) miles through the towns of Orange, Woodbridge and a portion of Bethany. The river flows through a variety of land cover types, including forested, agricultural and urban designations (University of Connecticut Center for Land Use Education and Research – UCONN CLEAR).[6] The Wepawaug River also contains some ponded areas including a local area drinking water reservoir, two recreational swimming areas, and a small lake (Lake Wepawaug).

The goal of this project is to investigate how flows from this river and watershed impact local beaches and the waters of Long Island Sound. The majority of the sources of bacteria are non-point, originating from a combination of sources rather than a single, identifiable point. These non-point sources of pollution can range from a variety of diffuse sources, including but not limited to urban and agricultural runoff, leaking septic tanks, improper boat waste disposal, pet waste, and wildlife. The nature of non-point sources makes identification, and thus remediation, extremely challenging.

Information from the City of Milford and Town of Orange Public Works and Health Departments indicates that homes in the town of Orange have subsurface sewage disposal systems while 99% of the watershed and coastal homes in Milford are connected to the public sewer system.

Figure 2: GIS map featuring general information of the Wepawaug River watershed at the sub-regional level



Bacteria Impairments In The Wepawaug River Sub Regional Basin

Map Data: CT DEEP Map Created: August 2011

Milford's Wepawuag River segment

Wepawaug River Watershed Association (WRWA) Background

Residents from the City of Milford recently formed the WRWA. This volunteer organization is recognized by the City of Milford and is overseen by and partnered with the Milford Open Space and Natural Resource Agent. The Towns of Orange and Woodbridge have also agreed to assign volunteers.

Residents identified the need for a holistic watershed plan which would include all three towns that the Wepawaug flows through. Both the impacts and the benefits from the Wepawaug are seen by all towns. Overall the group understands the need to identify points of degradation as well as areas of improvement and integrate the findings with education opportunities for the public. The group has already begun this initiative by conducting four riverwalks designed to educate and allow for participation.

The WRWA applied for a CT Department of Agriculture Viability Grant to fund the cost of the water sample bacterial analyses. WRWA was also awarded two other grants. One from the River's Alliance to purchase a Yellow Springs Instrument (YSI) water quality probe to measure for parameters such as temperature, specific conductivity, pH, and dissolved oxygen. These water quality parameters will assist in determining seasonal trends and pollutant loading to the watershed. Another grant was a donation of a Turner Designs Aquafluor® hand-held field fluorometer with both optical brightener and fluorescein dye filters to assess pollutant loadings from potential failing septic systems and illicit discharges.

Two WRWA volunteers attended the CT DEEP Riffle Bioassessment by Volunteers (RBV)[9] training class and conducted a macroinvertebrate collection and identification sampling in the Wepawaug River in Orange. Two subsequent mini-RBV sample collections were conducted near WR2 (Eisenhower Park) and displayed to scouts and residents attending one of four river education sessions conducted by WRWA. The same two volunteers also attended the Southwest Conservation District's "Streamwalk" survey training class and subsequently a 1.1 mile section of the watershed in Milford was walked[10].

Project Scope of Work

The WRWA began this study by conducting a street survey to determine locations for sampling that would adequately assess any pollutant loading. Sample locations were chosen near sewage pumping stations, incoming streams, areas with wildlife and farms, areas of residential subsurface sewage disposal systems, and commercial business zones. Samples were collected during both dry and wet weather conditions through most of the year. Storm drains and pipes were noted if there was flowing water in them and then sampled.

The project goal was to have a better understanding of the types of pollutant loadings flowing to the harbor and impacting the bathing and shellfishing waters of Long Island Sound. In addition, other potential pollutant loadings such as wildlife and areas of erosion were also identified. Erosion is an important component to the water quality issue as increased sediments reduce depth which results in elevated water temperatures and lower dissolved oxygen. Sediments also smother naturally setting oysters in the harbor areas and the subsequent need for harbor dredging further disrupts the habitat. Corrective actions and best management practices (BMPs) may result in improved water quality for the river.

In addition, four (4) riverwalk education sessions were conducted in Milford along the river, inviting residents to learn more about the history, diversity, habitats and issues concerning their watershed. Two similar walks were also conducted in Orange by the Orange Land Trust and Conservation Committee.

Other partners, including but not limited to, were the Housatonic River Estuary Commission (HREC), Milford Inland Wetlands and Conservation Commission who assisted with the public outreach providing informational brochures and speaking during public outreach sessions. The Town of Orange Health Department provided compliance assistance with regards to one failing subsurface sewage disposal system identified. The Milford Health Department, Inland Wetlands Office, and Public Works Department assisted with follow-up actions and the correction of one discharge. The Southwest Conservation District provided training and guidance with regards to options for implementing "best management practices" and other effective corrective actions. HarborWatch provided training and calibration of the YSI meter. National Resource Conservation Service (NCRS)[11] provided educational information regarding non-point pollution and BMPs.

Water Sampling

- ***Bacterial Monitoring***

Water samples for the purpose of bacterial monitoring were collected in sterilized bottles provided by the HarborWatch Laboratory in Westport, CT and the State of CT Department of Public Health (DPH) Laboratory in Rocky Hill, CT.

The Milford WRWA collected samples that were analyzed at the HarborWatch Laboratory for both fecal coliforms and *E. coli*. Harbor Watch has been awarded CT Agriculture Viability, CT DEEP, and EPA grants in the past to study water quality issues in the towns of Darien, Norwalk and Westport. They have a CT DEEP approved Quality Assurance Program Plan (QAPP) and are an EPA and State of CT certified laboratory. HarborWatch conducts training of volunteers and calibrates the YSI meters as part of their QAPP.

A Registered Sanitarian for the Town of Orange collected samples that were analyzed by the State of CT DPH Laboratory in Rocky Hill, CT for *E. coli*. following State DPH and EPA protocols. The CT State Laboratory also has a State, EPA, and FDA approved QAPP.

At the time of collection, temperature controls were submitted to verify the appropriate handling of the samples. Samples were brought to the respective labs and processed within 24-hours of collection following protocols for the membrane filtration method reporting results in colony forming units (CFUs)/100 ml. All State and EPA quality assurance plan (QAP) requirements were followed including the submission of control blanks and duplicate and/or replicate-split samples. Additionally, samples were collected by each town at all sites on the same of seven (7) dates to better assess natural fluctuations. Station WR1 and WR1A were sampled by each town on three same dates with statistically similar results. There was one additional site in Milford, a catchbasin, that was sampled on five dates due to steam observed coming up from the drain. All locations had GPS latitude/longitude coordinates also recorded in the database.

Water quality monitoring was conducted from June of 2014 through September of 2015 along the Wepawaug River from below the Regional Water Authority reservoir in Orange, south to the dam at the head of Milford Harbor. The Wepawaug River runs from a small portion of Bethany through Woodbridge, Orange and Milford emptying into Milford Harbor - Long Island Sound. The Regional Water Authority (RWA website) manages a drinking water reservoir at the north end of Orange, CT. The first sampling sites for this study are less than a half mile south of this reservoir. (See Table 1.) Sampling was conducted at a total of 17 routine sites with eight (8) as part of the grant in Milford, and an additional nine (9) as an in-kind match collected by the Town of Orange.

A total of 51 sample runs were conducted on 44 dates starting in May of 2014 and continuing through until September of 2015. There were 21 sample collection runs conducted during 2014 with twelve (12) in Milford and nine (9) in Orange. There were 30 sample collection runs conducted during 2015 with 17 in Milford and 13 in Orange. Orange samples were collected during the summer months only.

A total of 351 water samples were collected and analyzed for indicator bacteria. There were 184 samples were collected by WRWA volunteers in Milford as part of the Ag Viability grant. The Town of Orange Health Department collected 167 samples as an in-kind match. Between 8 and 38 samples were collected at each location. Rainfall was measured from a manual rain gauge at home in Milford as well as at the Orange Town Hall. The CT Agricultural Experiment Station (CAES) online rainfall data was also reviewed[12]. There were 11 wet weather samples collection dates and 18 dry weather sample collection dates for Milford. Orange collected samples on eight (8) wet weather dates and 14 dry weather dates.

Results were elevated for both *E. coli* and fecals after all rainfall events on day zero (0) and for samples collected within two (2) days after rainfall events of ≥0.65”. Results were in the thousands for collection on day zero (0) during a rainfall event. These were considered to be the “wet weather” samples as compared with the “dry weather” samples collected on days one to three after <0.65” of rain and collected four (4) or more days after all rainfall events. The majority of bacterial levels returned to “normal” background levels by the third day after rainfall events. Sample results of zero (0) were recorded as one (1) for the data analysis and sample results reported as “too numerous to count” (TNTC) were not included in the geometric mean analyses. The higher result was used for geometric means for the duplicate samples. (See Tables 2 and 3.)

Results from the stations in Orange, CT were consistently lower than those from the most southern six (6) sites in Milford. The highest wet weather results were from the southernmost three sites closest to the harbor. Bacteria levels increased at sites south of the Post Road which is consistent with general water quality trends and increase in commercial area (urbanization) and runoff. Results may also be subject to bacterial impact from the large number of geese at stations WR6, WR7, and WR8.

Dry weather *E. coli* results were very comparable to the fecal coliform results. Greater variability was observed between *E. coli* and fecal results with “wet weather” samples. Both *E. coli* and fecals were significantly lower during the months of December through April with water temperatures below 10^{o} C.

Stations WR1 And WR2 were the only two sites in Milford that met the FDA shellfishing criteria during dry weather for fecals. No sites met the shellfishing fecal criteria during wet weather.

Many sites met the *E. coli* criteria for "swimmable" during dry weather for the geometric mean but most had at least one elevated result that would not allow the overall criteria to be met. WR2 and Prudden Lane met the wet weather geometric mean but also had elevated single samples. Several sites would meet the "non-swimmable" criteria during dry weather but not during wet weather conditions.

Table 1. ***Sampling Location Descriptions (North to South).***
Note: ***GPS coordinates (latitude and longitude) are recorded in the database for each location.***

Sampling Site	Description
Camp Cedarcrest North (CC-N)	Located in the Wepawaug River approximately 0.5 miles south of the Regional Water Authority reservoir.
Camp Cedarcrest South (CC-S)	Approximately 300' south of CC-N.
806 Mapledale	Creek that flows into the Wepawaug between CC-S and Old Grassy.
Old Grassy Road bridge	Wepawaug River residential area north of Lake Wepawaug.
Wright's Pond	Small pond that has a population of resident Canada geese and flows into the Wepawaug during seasonal periods of high flow and with rainfall events.
Prudden Lane bridge	Southern outfall of Lake Wepawaug - all homes on the lake have SSDS. It is a swimming/recreational area for local residents.
Derby Milford Road bridge	Wepawaug River just south of a golf course.
Clark Lane creek	Creek in Orange that feeds to the Flax Mill side creek (WR1A) site. Creek flows past an area of septic concern as well as through the golf course with a pond with resident geese and then more residential homes.
Flax Mill Road bridge (WR1)	Wepawaug River at the Orange/Milford town line. There is a pump station, storm water drainage and SSDS in the immediate vicinity.
Flax Mill Road (side creek) (WR1A)	Small creek that flows intermittently just south of the Flax Mill Road site and connected to the Clark Lane site.
WR2 – Eisenhower Park	Eisenhower Park site in Milford. Park has dogs, horses, and geese.
WR3 – Walnut Street bridge	South of WR2 – just south of the I-95 overpass.
WR4 – Post Road (Rt 1) bridge - N side	Route 1 - commercial area, pump station, and storm drainage.
WR5 – Post Road (Rt 1) bridge- S side	South side to asses for impacts from stormwater pipes under the bridge.
WR6 – upper North St. duck pond waterfall	Resident geese and stormwater south of Rt 1.
WR7 – River Street bridge	Just below lower duck pond also with large numbers of geese and stormwater.
WR8 – New Haven Avenue bridge	Most southern Site at the dam just above Milford Harbor. The final samples here indicate the impacts to the harbor and LIS.
CB – West River Street (special sample)	Catchbasin with steam and fecal counts at 25,000 CFUs/100 ml. This was reported to the Town with post- repair sample results of 350 fecal CFUs/100 ml.

Table 2. North to South Fecal Coliform Results (CFUs/100ml.).

Sampling Station	# Samples Dry	Dry Geo. Mean	Dry Min./Max.	# Samples Wet	Wet Geo. Mean	Wet Min. / Max.
WR1	16	22.1	2 / 300	9	131.3	10 / 500
WR1A	7	90.2	2 / 2,000	2	>2,000	2200 /(*TNTC)
WR2	15	29.3	2 / 400	7	138.8	8 / 2,400
WR3	16	58.1	4 / 580	8	237.5	16 / 5,500 (*TNTC)
WR4	8	65.9	18 / 330	6	442.3	22 / 11,000
WR5	14	50.1	4 / 1,040	7	250.0*	4 / 9,600 (*TNTC)
WR6	16	45.7	1 / 460	10	458.6	16 / 4,900
WR7	16	161.8	8 / 1,800	11	801.3	50 / 6,800
WR8	16	69.6	22 / 1,000	10	586.2	68 / 7,200

**Three (3) TNTC (too numerous to count) results were not included in geometric mean analyses.*

Note: Shellfishing areas are closed with water sample fecal coliform results of >14 CFUs/100ml and geometric means of >31 CFUs/100ml.[4] (= does not meet criteria and = meets criteria)

Table 3. North to South *E. Coli* Results (CFUs/100ml).

Note: WR4 and WR5 were not sampled consistently due to bridge work and closure on either side of the bridge.

Sampling Station	Total # samples	# Dry	Dry Geo. mean	Dry Min. / Max.	# Wet	Wet Geo. mean	Wet Min. / Max.
Camp Cedarcrest –N	17	13	67.7	31 / 240	4	281.9	64 / 1,400
Camp Cedarcrest – S	19	13	45.5	9 / 140	6	429.1	99 / 3,900
806 Mapledale	21	14	123.8	1 / 930	7	632.4	190 / 3,900
Wright's Pond	8	6	137.5	20 / 2,200	2	1131.8	210 / 6,100
Old grassy Hill Rd.	20	12	199.9	75 / 410	8	498.6	120 / 1,400
Prudden lane	22	14	22.9	9 / 86	8	85.4	10 / 690
Derby Milford Road	22	14	56.8	10 / 170	8	240.6	75 / 1,500
Clark Lane	9	4	88.7	52 / 300	5	741.8	110 / 5,200
WR1	39	25	41.5	2/360	14	244.1	22/4900
WR1A - Creek	16	9	78.7	10 / 2,000	7	1583.2	490 / 16,000
Wr2	22	16	27.8	2/360	6	189.6	12/2400
Wr3	29	19	67.9	2/360	10	524.6	12/2400
WR4	14	18	64.1	2/1200	4	806.6	46/10000
WR5	21	15	43.4	14/350	6	348.7	150/9500
WR6	29	18	56.3	1/1100	11	611.4	38/8000
WR7	28	17	138.9	8/1500	11	817.6	50/6300
WR8	27	17	61.0	10/480	10	531.0	58/6800

Note: The EPA limits for freshwater bathing areas is a single sample level of 235 Escherichia coli bacteria CFUs (colony forming units)/100 ml with a geometric mean of not greater than 125 CFUs. (= does NOT meet criteria and = meets criteria) The criteria for recreational non-swimming is a single sample of 410 CFUs/100 ml and geometric mean of <126 CFUs/100 ml.[3]

Additional monitoring conducted to develop a database of background ("normal") seasonal and weather related conditions:

- ***YSI Probe Monitoring***

In addition to the bacteria monitoring, a Yellow Springs Instruments (YSI) Quatro Professional Plus probe was used to monitor the water quality parameters of temperature, pH, specific conductivity (SPC) and dissolved oxygen (DO) at the Milford sampling locations. The probe was calibrated by the HarborWatch Laboratory Staff on a regular basis following the manufacturer's instructions.

Readings were recorded at water depths of <12 inches. Sample results were analyzed for trends correlating levels of bacteria against seasonal parameters and rainfall amounts. All measurements were within normal and expected ranges for the sites, including some low DO readings during the warmest weeks of the year. There is a slight increase in pH at the three most southern stations.

Table 4. 2015 YSI Geometric Means for SPC and pH.

Station #	# samples	Specific conductivity Geo. mean	pH Geo. mean
WR1	14	289.8	7.36
WR1A	10	270.8	7.19
WR2	13	279.9	7.30
WR3	16	297.6	7.30
WR4	5	291.3	7.30
WR5	9	281.3	7.36
WR6	11	294.6	7.99
WR7	14	327.9	7.94
WR8	14	290.3	7.86

Table 5. 2015 YSI Monthly Sample Geometric Means.

Month	# Samples / # Dates	Air C^o Geo. mean	Water C^o Geo. mean	DO Geo. mean	SPC Geo. mean	pH Geo. mean
March	8 / 1 day	2.93	5.8	14.24	280.8	7.29
April	7 / 1 day	17.3	11.0	13.46	287.3	7.72
May	7 / 1 day	16.1	17.3	8.34	320.5	7.40
June*	16/2 days*	15.0*	18.5*	7.4	285.2	7.4
July	29 / 4 days	27.1	22.8	7.03	275.0	7.65
Aug.	22 / 3 days	27.8	23.6	5.30	304.2	7.57
Sept.	7 / 1 day	25.7	21.7	6.18	273.7	7.45

**Note: There was a cold snap on 6/2/15 with air temperature of 9.4^o C. and water at 15.0^o C. The 6/14/15 temperatures were "normal" with 24.0^o C. for air and 23.0^o C. for water.*

- **Fluorometer Readings**

An *Aqua*Fluor® handheld field fluorometer was donated by Turner Designs to aid in identifying sources of sewage from human activity. Filters for optical brightener testing and fluoresceine dye were installed. Optical brighteners are released into the environment from laundry detergents and are used to brighten fabric colors. Water samples with elevated bacterial levels may be sourced more easily as septic releases if levels of optical brighteners are also elevated.

Prior to use, the fluorometer was calibrated according to the manufacturer's instructions[6] using a stock solution of commercial Tide® laundry detergent at 50 ppm. The fluorometer reading was 70.19 ppm utilizing the stock solution. Readings were averaged and resulting in a >5 ratio between the standard solution and the blank which were considered to be "acceptable" for the stock solution to be used for calibration purposes. The stock sample was further validated according to the manufacturer's instructions utilizing ultraviolet (UV) light to "excite" the optical brighteners. The UV results were slightly higher indicating the solution was at proper concentration.

Control blanks consisting of distilled water, bottled water, and tap water were tested at the start of each sampling run. Distilled water results were -0.199 to 0.005 ppm. Bottled water results were -0.02 to 0.281 ppm. Tap water results were 0.037 to 0.441 ppm. The fluorometer was recalibrated with the standard stock solution half way through the season with a result so 68.9 ppm indicating that the unit was still functioning accurately. The cuvette was rinsed between samples with distilled water or bottled water. New cuvettes were used after any result greater than 2.0 ppm.

In addition, two samples were collected for reference from a direct sewer discharge of fresh laundry wastewater with a result of 28.7 ppm and from an overflowing septic tank with a result of 6.3 ppm. A groundwater standpipe at a depth of 90" that was located only a few feet from the failing septic was also sampled with results of 0.306-0.391 ppm indicating that soil does a good job of removing optical brighteners. Three additional samples were collected from another failing septic where flows were draining from the lawn to the road. Optical brightener results were 0.30 to 0.468 ppm which were lower than the nearby stream which had results of 1.105 to 2.60 ppm. This stream will be further assessed as levels >1.7 ppm may indicate an overflowing septic system.

There were 18 sample runs conducted collecting water samples that were read for the presence of optical brighteners. Fifteen of the sample runs were routine water sample collection dates and the first three were special sample runs during the months of March and April when ground water was at its peak and seasonal septic failure is expected. Timing is key to identifying seasonal septic failure. Fluorometer readings were recorded from March through September with no seasonal trends observed. Readings were only slightly elevated on days zero to two after rainfall events of ≥0.65".

A total of 131 samples were analyzed for optical brighteners from the routine water sample collection sites. In addition, 21 groundwater samples were collected in the early spring during the highest groundwater levels of the year to assess for optical brighteners indicating seasonal failing subsurface sewage disposal systems (SSDS). Background levels of optical brighteners were evaluated between March and September and assessed for trends with changes in levels of bacteria. Samples collected in the spring from groundwater sources in areas of septic ranged from 0.197 to 0.812 ppm indicating no septic failure or that soils do a good job of filtering out optical brighteners.

Levels of optical brighteners consistently at <1.7 ppm were considered background as these levels were found at all routine sampling locations. Levels that were consistently >1.7 ppm were considered have optical brighteners and to be directly influenced by laundry wastes. Two special study sites that flow from one to the other (Clark Lane and WR1A) were identified as having "above normal" levels of optical brighteners and they also had elevated levels of *E. coli.* A failing subsurface sewage disposal system (SSDS) was identified in this area and subsequently repaired. This area will be further assessed in 2016 for a reduction in optical brighteners after this repair. The Wright Pond and Old Grassy sites has lower ("background") levels of optical brighteners but elevated levels of *E. coli.* Wright's pond also has large numbers of resident geese.

Table 6. Fluorometer Readings North to South.

Sampling Station	# samples	Geo. Mean
Camp Cedarcrest –N	10	1.13
Camp Cedarcrest – S	7	1.11
806 Mapledale	12	.54
Wright's Pond	8	1.13
Old Grassy Hill Road	11	.91
Prudden Lane	13	.92
Derby-Milford Road	12	1.01
Clark Lane	8	1.93
WR1	14	.92
WR1A	10	1.71
WR2	1	.77
WR3	6	1.05
WR4	1	.99
WR5	2	1.13
WR6	5	1.06
WR7	4	1.05
WR8	4	1.10

- ***Catch Basin and Sanitary Surveys***

A pollution source study was conducted beginning in 2014. The City of Milford has 104 homes along the river with 102 connected to public sewers. The Town of Orange has 110 homes directly along the river all serviced by SSDS. Approximately eight (8) miles along both sides of the river were surveyed between Milford and Orange. All catch basins (storm drains) were visually inspected for flowing water, odors, foam, discoloration and/or sheen with approximately 12 requiring follow-up investigation. Water samples were collected and analyzed for optical brighteners from 12 drains with water flowing through them during dry weather. One drain in Orange was observed having soap suds in it from a nearby failing septic system. The Orange Health Department ordered the system to be repaired and will collect additional samples in 2016. An inventory was completed of all locations surveyed and actual and potential pollution sources.

Storm drains were also surveyed during January and February of 2015 as discharges would have water warmer than the ambient air temperature and “steam” will be easily observed. This method of surveying is extremely effective when done during frigid conditions. Two such storm drains in Milford were found utilizing this survey method and one was sampled with fecal coliform results of 3,000 and 25,000/100 ml. The water temperature was 35.4^{o} C., which was much higher than the average of 5.0^{o} C. at all the other stations. This location was south of station WR7 and flowing directly to the river. The discharge was reported to the Milford Public Works Department and promptly corrected. Sample results after the correction were 380 and 80 fecals/100 ml. respectively.

Results of the bacterial samples indicate that rainfall events of >0.65” will negatively impact the river’s water quality primarily on days zero, one, and two after a rainfall event due to the amount of runoff entering the stormwater system. Bacterial levels normally return to background conditions by day three after rainfall events greater than 0.65”.

Results and Discussion

This study has been conducted with the objectives of establishing monitoring stations within the watershed staring in Milford and moving northward, collecting water sampling to assess “normal” conditions and conditions that result in bacterial loading, and then to identify the sources of pollution. All of these individual objectives are to be used ultimately to improve the water quality in the River and prioritize the implementation of best management practices (BMPs). All information and data will be incorporated into a draft “Watershed Management Plan” and submitted to the CT DEEP and Southwest Conservation District for review and ultimately approval.

The watershed survey will provide a list of pollution sources that may be able to be corrected or better managed. The pollution source inventory will locate and identify all pipes, catchbasins, and areas of erosion. Water sampling results will provide the data necessary to estimate rain event impacts and recovery times for the shellfishing areas impacted. Specific sites along the river will be used as education “kiosks” to better educate the public about issues such as fecal contributions from waterfowl being fed along the river, and proper disposal of landscaping wastes.

Additional sampling is planned for 2016 if funding can be attained for analyses. Additional wet weather samples would be useful in identifying new pollution sources.

After this study, the watershed group would also like to continue to expand its surveys to the remaining tributaries in Milford that also directly impact our recreational and commercial resources. These include the Indian River, Oyster River, Calf Pen Creek, Stubby Brook, Beaver Brook, and the Housatonic River.

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